

**REMARKS**

Examiner Kin Chan Chen is thanked for his examination of the subject Patent Application. The Specification, Drawings and Claims have been carefully reviewed with respect to the objections and 35 USC § 112 rejections as well as Examiner Kang's suggestions and the Claims have been amended and are considered to be in condition for Allowance.

**Claim Status**

Claims 1-7, 9, 11-21, 23, 25-27 and 28-32 remain in this application. Claims 8, 10 and 24 had been previously cancelled. Claim 22 is cancelled at this time. New Claims 28-32 are added at this time.

**Detailed Action Item 1****Claim Objections 37 CFR 1.75(c)**

The objected to Claims 9 and 23 have been amended in the manner discussed below. The objected to Claim 22 has been cancelled because it fails to further limit the independent Claim 14.

**Additional Corrections**

This review of the claims vis-à-vis the specification has been helpful to identify a typographical error in Claim 6 relative to the second insulative layer described in Claim 1. The dielectric constant should read as a range of "2.2 to 3.5" not as "2.5 to 3.5". This is borne out by noting that the second insulative layer described in Claim 14 is further limited by a range of "2.2 to 3.5" as found in Claim 20. Furthermore, the range of "2.2 to 3.5" is found in the specification at

page 16, lines 19-23 in a general discussion of low-k dielectric materials. No other limiting range is found in the specification. Therefore Claim 6 has been amended to correct the apparent typographical error.

### **Detailed Action Items 2, 3 & 4**

### **Claim Rejections - 35 USC § 112**

Reconsideration of the rejection of Claim 9 under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification is requested based on the following arguments.

Dependent Claim 9 has been amended as an independent claim with all the limitations found in Claim 1 replacing "I-line photoresist" with "spin-on organic oxide". Contrary to the Examiner's observation that dependent Claim 9 is new matter that was not described in the specification, the use of "spin-on organic oxide" is respectively found in the specification at page 19, line 19 and at page 20, line 7 as follows:

"It is disclosed hereby that the proper fill material is a specific photoresist, namely, I-line photoresist (I-line PR), or, a spin-on organic oxide such as SILK and FLARE."

"Thus, I-line PR, or, spin-on organic oxide (250) is formed over the substrate, including the hole opening, as shown in Fig. 2e, and any excess is removed and planarized with respect to the surface of the substrate using chemical-mechanical polishing (CMP), or by etching, as shown in Fig. 2f."

### **New Claims Dependent on Claim 9**

Currently reformed independent Claim 9 gives rise to additional dependent Claims 28 and 29 reflecting the use of "copper" and "low-K" materials as found in corresponding Claims 3, 6 and 11 which are dependent upon Claim 1.

**Claim Rejections - 35 USC § 112**

Reconsideration of the rejection of Claim 23 under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention is requested based on the following arguments.

Dependent Claim 23 has been amended as an independent claim with all the limitations found in Claim 14 replacing "l-line photoresist" with "spin-on organic oxide". The reasoning behind this amendment is the same as given above for amended Claim 9, because both similarly assert "spin-on organic oxide" as an alternative to "l-line photoresist" as discussed in the specification.

**New Claims Dependent on Claim 23**

Currently reformed independent Claim 23 gives rise to additional dependent Claims 30, 31 and 32 reflecting the use of "copper" and "low-K" materials as is found in corresponding Claims 16, 17, 20 and 25 which are dependent on Claim 14.

**Detailed Action Item 5****Allowable Subject Matter**

The Applicant acknowledges and agrees with Examiner Chen that the instant invention teaches a method for eliminating volcano effect in dual damascene fabrication.

**CONCLUSION**

We have reviewed the related art references made of record and agree with Examiner Chen that none of these suggest the present claimed invention.

In light of the above arguments, it is suggested that the Claims now clearly describes the invention. All claims are therefore believed to be in condition for allowance.

Allowance of all claims is therefore respectfully requested.

It is requested that should Examiner Chen not find that the Claims are now Allowable that the Examiner call the undersigned attorney at 845-452-5863 to overcome any problems preventing allowance.

Respectfully submitted,

A handwritten signature in black ink, appearing to be 'SBA', with a long horizontal flourish extending to the right.

Stephen B Ackerman, Reg. No. 37,761

**Appendix****MARKED UP CLAIMS COPY**

1. (PREVIOUSLY AMENDED) A method of eliminating volcano effect in dual damascene comprising the steps of:

providing a substrate having first and second insulative layers, optionally separated from each other by an intervening etch-stop layer formed thereon said substrate;

forming a hole opening through said first and second insulative layers;

forming a fill material over said substrate, including in said hole opening, wherein said fill material comprises I-line photoresist;

removing any excess fill material over said hole opening, wherein said removing said any excess fill material is accomplished by chemical mechanical polishing or by etching;

forming a trench opening in said second insulative layer over said hole opening in said first insulative layer, thus completing the forming of said dual damascene structure on said substrate;

removing said fill material from said hole opening;

depositing metal in said dual damascene structure; and

removing excess metal to complete the forming of said dual damascene without the volcano effect.

2. The method of claim 1, wherein said substrate is silicon.

3. The method of claim 1, wherein said first insulative layer is a low-k dielectric having a dielectric constant between about 2.2 to 3.5.

4. The method of claim 1, wherein said first insulative layer has a thickness between about 1000 to 10000 Å.

5. The method of claim 1, wherein said optional intervening etch-stop layer is silicon nitride.

6. (CURRENTLY AMENDED) The method of claim 1, wherein said second insulative layer is a low-k dielectric having a dielectric constant between about [2.5] 2.2 to 3.5.

7. The method of claim 1, wherein said second insulative layer has a thickness between about 1000 to 10000 Å.

8. (CANCELLED)

9. (CURRENTLY AMENDED) [The method of claim 1, wherein said fill material comprises spin-on organic oxide.] A method of eliminating volcano effect in dual damascene comprising the steps of:

providing a substrate having first and second insulative layers, optionally separated from each other by an intervening etch-stop layer formed thereon said substrate;

forming a hole opening through said first and second insulative layers;

forming a fill material over said substrate, including in said hole opening, wherein said fill material comprises spin-on organic oxide;

removing any excess fill material over said hole opening, wherein said removing said any excess fill material is accomplished by chemical mechanical polishing or by etching;

forming a trench opening in said second insulative layer over said hole opening in said first insulative layer, thus completing the forming of said dual damascene structure on said substrate;

removing said fill material from said hole opening;

depositing metal in said dual damascene structure; and

removing excess metal to complete the forming of said dual damascene without the volcano effect.

10. (CANCELLED)

11. The method of claim 1, wherein said metal comprises copper.

12. The method of claim 1, wherein said metal has a thickness between about 1000 to 15000 Å.

13. (PREVIOUSLY AMENDED) The method of claim 1, wherein said removing said excess metal is accomplished by chemical mechanical polishing.

14. (PREVIOUSLY AMENDED) A method of eliminating volcano effect in dual damascene comprising the steps of:

providing a substrate having a passivation layer formed over a first metal layer formed on said substrate;



forming a first insulative layer over said substrate;

forming an optional etch-stop layer over said first insulative layer;

forming a second insulative layer over said etch-stop layer;

forming a first photoresist layer over said second insulative layer and patterning said photoresist to form a first photoresist mask having a hole pattern;

etching said first and second insulative layers, including said optional etch-stop layer through said hole pattern to form a hole reaching said passivation layer;

removing said first photoresist mask;

forming a fill material over said substrate, including in said hole opening, wherein said fill material comprises I-line photoresist;

removing any excess fill material over said hole opening, wherein said removing is accomplished by chemical mechanical polishing;

forming a second photoresist layer over said substrate, including said hole opening and patterning said second photoresist to form a second photoresist

mask having a trench pattern;

etching said second insulative layer through said trench pattern in said second photoresist mask to form a trench in said second insulative layer, thus completing the forming of said dual damascene structure in said substrate;

removing said second photoresist mask;

removing said fill material from said hole opening;

depositing a second metal in said dual damascene structure; and

removing excess metal to complete the forming of said dual damascene without the volcano effect.

15. The method of claim 14, wherein said substrate is silicon.

16. The method of claim 14, wherein said first metal is copper.

17. The method of claim 14, wherein said first insulative layer is a low-k dielectric having a dielectric constant between about 2.2 to 3.5.

18. The method of claim 14, wherein said first insulative layer has a thickness

between about 1000 to 10000 Å.

19. The method of claim 14, wherein said optional etch-stop layer is silicon nitride.

20. The method of claim 14, wherein said second insulative layer is a low-k dielectric having a dielectric constant between about 2.2 to 3.5.

21. The method of claim 14, wherein said second insulative layer has a thickness between about 1000 to 10000 Å.

22. (CANCELLED)

23. (CURRENTLY AMENDED) [ The method of claim 14, wherein said fill material is spin-on organic oxide.] A method of eliminating volcano effect in dual damascene comprising the steps of:

providing a substrate having a passivation layer formed over a first metal layer formed on said substrate;

forming a first insulative layer over said substrate;

forming an optional etch-stop layer over said first insulative layer;

forming a second insulative layer over said etch-stop layer;

forming a first photoresist layer over said second insulative layer and patterning said photoresist to form a first photoresist mask having a hole pattern;

etching said first and second insulative layers, including said optional etch-stop layer through said hole pattern to form a hole reaching said passivation layer;

removing said first photoresist mask;

forming a fill material over said substrate, including in said hole opening, wherein said fill material comprises spin-on organic oxide;

removing any excess fill material over said hole opening, wherein said removing is accomplished by chemical mechanical polishing;

forming a second photoresist layer over said substrate, including said hole opening and patterning said second photoresist to form a second photoresist mask having a trench pattern;

etching said second insulative layer through said trench pattern in said second photoresist mask to form a trench in said second insulative layer, thus completing

the forming of said dual damascene structure in said substrate;

removing said second photoresist mask;

removing said fill material from said hole opening;

depositing a second metal in said dual damascene structure; and

removing excess metal to complete the forming of said dual damascene without  
the volcano effect.

24. (CANCELLED)

25. The method of claim 14, wherein said second metal comprises copper.

26. The method of claim 14, wherein said second metal has a thickness between  
about 1000 to 15000 Å.

27. (PREVIOUSLY AMENDED) The method of claim 14, wherein said removing  
Said excess metal is accomplished by chemical mechanical polishing.

28. (NEW) The method of claim 9, wherein said first and second insulative and  
layers are a low-k dielectric having a dielectric constant between about 2.2 to 3.5.

- 29.(NEW) The method of claim 9, wherein said metal comprises copper.
- 30.(NEW) The method of claim 23, wherein said first and second insulative layers are a low-k dielectric having a dielectric constant between about 2.2 to 3.5.
- 31.(NEW) The method of claim 23, wherein said first metal is copper.
- 32.(NEW) The method of claim 23, wherein said second metal comprises copper.